

# APTI 418: CONTROL OF NOX EMISSIONS

August 11 – 13, 2015  
Norristown, Pennsylvania

## AGENDA

### Course Location

Pennsylvania Department of  
Environmental Protection  
Southeast Regional Office  
2 East Main Street  
Norristown, PA 19401

### Course Director

Tim C. Keener, PhD, PE, QEP  
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Date/Time	Student Manual Chapter	Subject
<hr/> <b>Tuesday, August 11</b>		
<b>Introduction and Organization of the Course</b>		
9:00-10:00 AM	1	<b><u>Introduction to NO<sub>x</sub> Control</u></b> Regulation of NO <sub>x</sub> Definition of NO <sub>x</sub> Origins of NO <sub>x</sub> NO <sub>x</sub> formation mechanisms in combustion processes Anthropogenic sources NO <sub>x</sub> emission trends Ozone seasonal emissions Emissions projections
10:00-10:15 AM		<b>Break</b>
10:15-12:00 PM	2	<b><u>NO<sub>x</sub> Regulatory Programs</u></b> Introduction NO <sub>2</sub> NAAQS Ozone NAAQS PM <sub>10</sub> and PM <sub>2.5</sub> NAAQS Visibility impairment Historic review of ozone control Strategies Acid rain Other programs
12:00-1:00 PM		<b>Lunch</b>
1:00-2:30 PM	3	<b><u>Combustion Systems &amp; NO<sub>x</sub></u></b> Diffusion and premixed flames Flame temperatures Boiler burners Reciprocating engines Combustion turbines

2:30-2:45 PM	<b>Break</b>
2:45-4:30 PM	4 <b><u>NO<sub>x</sub> Control by Reducing Temperature</u></b> Flame temperature and NO <sub>x</sub> Water Injection Flue gas recirculation Lean Premixed combustion Summary
4:30 PM	<b>Adjourn</b>

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**Wednesday, August 12**

8:30-10:00 AM	5 <b><u>Oxygen Based NO<sub>x</sub> Controls</u></b> Combustion staging concepts Reduced Excess Air Stratified combustion in large furnaces Low NO <sub>x</sub> burners Reburning Summary
10:00-10:15 AM	<b>Break</b>
10:15-12:00 AM	6 <b>Reciprocating Internal Combustion Engines</b> Combustion control Post-combustion control Case study
12:00-1:00 PM	<b>Lunch</b>
1:00-2:30 PM	7 <b>Gas Turbines</b> Introduction Combustion modification controls Post combustion controls
2:30-2:45 PM	<b>Break</b>
2:45-4:30 PM	8 <b>Back End Controls</b> Selective non-catalytic reduction (SNCR) Selective catalytic reduction (SCR) Non-selective catalytic reduction (NSCR) Emerging Technologies
4:30 PM	<b>Adjourn</b>

<b>Date/Time</b>	<b>Student Manual Chapter</b>	<b>Subject</b>
<b>Thursday, August 13</b>		
8:30-9:30 AM	<b>9</b>	<b>Emission Measurement, Monitoring &amp; Reporting</b> CEM regulatory program Measurement techniques CEM systems Quality assurance and quality control Oxygen concentration monitors Emissions calculations
9:30-10:30 AM	<b>10</b>	<b>Inspecting Permitted Emission Sources</b>
10:30-10:45 AM	<b>Break</b>	
10:45-12:00 AM	<b>Post-test</b>	
12:00 PM	<b>Adjourn</b>	

### **ABOUT THE INSTRUCTOR**

**Dr. Tim C. Keener, P.E., QEP**, is a Professor Emeritus of Environmental Engineering at the University of Cincinnati (UC) in the School of Biomedical, Chemical and Environmental Engineering. He served as the Area Coordinator for the Air Pollution Control/Air Quality Management Program at UC for over 33 years. A long-time member of the Air and Waste Management Association, Dr. Keener was the Technical Editor-in-Chief of its technical journal, the *Journal of the Air and Waste Management Association* from 2003 - 2012. He obtained a B.S. in Mechanical Engineering and an M.S. and PhD in Environmental Engineering from the University of Tennessee. He has published over 200 technical papers and reports on topics related to air pollution control including the control of SO<sub>x</sub> and NO<sub>x</sub>, and is the holder of 4 patents for air pollution control fundamentals and processes. His work in air pollution control is internationally known and he has directed the research of more than 65 M.S. and PhD graduates from UC.